Electro-Technology

ANNOTATED
EDITORIAL INDEX

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SCIENCE AND ENGINEERING

Dielectrics

Molecular Behavior of Composite Electrical Insulation, C. R. Vail ..... Feb 81
The fundamental nature of materials bears an intimate relationship to their engineering properties. This is particularly true of composite electrical insulating materials and systems, owing to the interaction of various forms of matter—solid, liquid and gaseous—in various configurations and forms. The author first elucidates classical molecular theory, relates molecular behavior to dielectric properties, and then examines composite structures specifically. Illustrations and a bibliography are provided.

Electrical Insulation—1961-62, A. E. Javitz, *Editor* ..... Feb 99
A special 48-page research and application report which explores the interdisciplinary position of electrical insulating and dielectric materials in total electrical/electronic systems design. The eight articles which comprise this section include reviews of ceramic insulation, dielectric problems in micro-electronic devices, effects of space radiation on insulation, research progress in dielectrics, and current trends in materials and applications, among other subjects.

The "Unified Approach" in Dielectrics—Its Significance in Design Engineering, T. D. Callinan, D. J. Epstein, L. Feinstein, N. M. Bashara, and A. E. Javitz ..... Feb 99
A symposium-in-print elucidating (from several viewpoints) the unified approach in dielectrics, which considers as dielectrics all non-metals in their interaction with electric, magnetic and electromagnetic fields. Practical (and significant) implications in design engineering are drawn.

Ceramic Insulation—A State-of-the-Art Review, H. Thurnauer ..... Feb 102
A report on current research developments in ceramic insulating and dielectric materials. Problem areas in design engineering are introduced and discussed within the framework of structural properties, dielectric properties, thermochemical stability and contact reactions, and processing techniques. An extensive bibliography is included.

Dielectric Problems in Microelectronic Devices, P. White ..... Feb 106
An examination of the special problems created by the application of dielectric materials in microelectronic devices. The problems are discussed from the standpoint of both materials and processing techniques. The effect of techniques on the ultimate properties of the dielectric materials is developed. The responsibility of the circuit designer to evaluate materials and techniques so as to design for optimum performance of the final device is emphasized.

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Space-Radiation Effects on Electrical Insulation and Semiconductors, J. F. Weller, F. J. Campbell and J. W. Kallander ..... Feb 116
A study of outer-space radiation and its effects on organic insulating materials and semiconductors. The nature of Van Allen Belt radiation, cosmic rays and solar flares with types of radiation damage and effects on structure of materials, together with results of laboratory tests and missile shots. The mechanism of damage is reviewed.

Research Progress in Dielectrics—1961, A. E. Javitz ..... Feb 127
An on-the-spot review and interpretation of the 1961 National Academy of Sciences-National Research Council Conference on Electrical Insulation. The review covers a wide span of activity, including work in electrical discharges and tracking, dielectric properties of glasses, gamma-radiation-induced effects, space charges studies, breakdown phenomena, dielectric relaxation and cable insulation problems.

Dielectric Constant and Loss—Their Significance in Insulation Selection, A. H. Sharbaugh ..... Feb 146
A basic definition of dielectric constant and loss factor for electrical insulating materials based on macroscopic electrostatic theory and related to the atomic and molecular structure of the material. Discussion includes dependence of measured values on prevailing temperature and frequency. Further discussion includes measurement techniques at various frequencies.

Using Fast-Pulse Techniques To Study Insulating Materials, W. E. Spear ..... May 94
A study of fast-pulse techniques used in the investigation of semiconductor materials with relatively high resistivity may be adapted to the study of insulating solids, including organic insulators.

Mathematics

Principles and Techniques of Modulation, J. Hupert ..... Apr 94
The processing of a signal into a convenient region of frequency space to give desired transmission. Concepts of time and frequency spectra. Single- and multi-tone amplitude and angular modulation and their respective resolutions into Fourier and Bessel sidebands. Noise in modulation. Suppressed carrier modulation. Pulse-code modulation and sampling. Frequency- and time-division multiplexing.

Numerical Solutions to Differential Equations, B. H. Liebowitz ..... Apr 104
This article derives those equations which will be used by digital computers or desk calculators in generating particular solutions to first- and higher-order differential equations. Emphasis is placed on the character of numerical methods as opposed to analytical methods. Several methods,

together with illustrative examples, are presented, plus an appendix on error estimation for polynomial expansions.

Matrix Analysis in Control-Systems Networks, A. W. Langill, Jr. — May — 102
Definition of a matrix and some of its algebraic properties. Four-terminal "black box" simultaneous linear equations, and their equivalent representation by the parameter matrices (*Z*, *Y*, *A* and *H*). Cascaded four-terminal networks, their individual matrices and the overall matrix. The matrix procedure applied to a problem in determining the transfer voltage function of a complex circuit found in control systems.

Operational Calculus, C. K. Hager. — Jun — 93
Includes: Fourier series and the Fourier integral, unilateral and bilateral Laplace transforms, the inverse Laplace transform, and their mathematical properties. Plus: tables of transforms, the convolution integral and the *n*th order impulse function, physical systems, the classical and operational approaches to linear systems, the transfer function and the impulse response in linear systems. Applications to networks.

Dimensional Analysis, R. A. Deutsch. — Aug — 107
The techniques of dimensional analysis are applied to the derivation of equations which govern various physical phenomena, using the basic "dimensions" of the variables involved. Starting with Buckingham's Pi Theorem, the author demonstrates how the proper exponents for the variables are found and how the use of dimensionless groups reduces the amount of experimental data required for the solution of complex problems and for model scaling.

Ordinary Differential Equations, A. D. Kraus. — Dec — 109
Differential equations unquestionably constitute the most versatile and powerful general mathematical technique available to engineers for system and network analysis and design. The principles defined in our "Basic Differential Equations" (*Electrical Manufacturing*, July 1960) are projected to additional methods for solving equations and systems of them. Examples are included to demonstrate the important concepts.

Network Analysis

Linear and Nonlinear Circuits: A Selective Review of the Literature, J. J. Hupert. — Jan — 87
A critical and progressive guide to contemporary reference and text material in circuit analysis and synthesis. Linear and active network theory, lumped networks, and nonlinear circuit concepts are described, and recommended book and periodical sources are discussed.

Pulse-Transformer Circuits and Analysis—1, N. R. Grossner. — Feb — 71
Transient conditions rather than the steady state prevail in switching and pulse circuits. Transformers and circuit-analysis methods based on the sine wave are fundamental, of course, but interpretation and transformation are required for application to pulse signals and energy. This two-part article describes and illustrates the necessary mathematical methods for transient analysis, basing the discussion on the fundamental component—the pulse transformer.

Pulse-Transformer Circuits and Analysis—2, N. R. Grossner. — Mar — 80
The second half of this article introduces nonlinearities and distributed capacitance for the analysis of pulse response. The use of equivalent circuits for step-by-step study of pulse-transformer behavior is described.

Analysis of *N*-Terminal Networks and Some Applications, L. Weinberg. — Mar — 64
A discussion of the indefinite admittance and impedance matrix and the parameters that comprise the elements of the matrix. The transformation of terminal to port analysis in *n*-terminal networks; reduction of *n*-terminal to *p*-terminal network; examples and proofs leading to an understanding of the indefinite admittance matrix, transfer and driving-point impedance, reciprocity and duality.

Principles and Techniques of Modulation, J. Hupert. — Apr — 94
The processing of a signal into a convenient region of frequency space to give desired transmission. Concepts of time and frequency spectra. Single- and multi-tone amplitude and angular modulation and their respective resolutions into Fourier and Bessel sidebands. Noise in modulation. Suppressed carrier modulation. Pulse-code modulation and sampling. Frequency- and time-division multiplexing.

Matrix Analysis in Control-Systems Networks, A. W. Langill, Jr. — May — 102
Definition of a matrix and some of its algebraic properties. Four-terminal "black box" simultaneous linear equations, and their equivalent representation by the parameter matrices (*Z*, *Y*, *A* and *H*). Cascaded four-terminal networks, their individual matrices and the overall matrix. The matrix procedure applied to a problem in determining the transfer voltage function of a complex circuit found in control systems.

Graphical Analysis of Circuits in the S-Plane, A. Glaser. — May — 128
The general response of linear networks subjected to exponential, step and sinusoidal waveforms. The article concentrates on the source response term and advances a graphical method that facilitates the calculations in obtaining the result. The *RC* high-pass, bridged-T and shunt *RLC* networks are examined for their poles and zeros. A pole-zero plot indicates the solution of network response problems.

Operational Calculus, C. K. Hager. — Jun — 93
Includes: Fourier series and the Fourier integral, unilateral and bilateral Laplace transforms, the inverse Laplace transform, and their mathematical properties. Plus: tables of transforms, the convolution integral and the *n*th order impulse function, physical systems, the classical and operational approaches to linear systems, the transfer function and the impulse response in linear systems. Applications to networks.

Wide-Band Transformers and Associated Coupling Networks, T. R. O'Meara. — Sep — 80
Performance criteria and design objectives for wide-band transformers are defined, and the limitations inherent in conventional configurations and windings indicated. Lumped and distributed-parameter models of transformers and networks are compared. Methods of extending transformer frequency range are outlined. Discussions are augmented by numerous cited references for details.

Piecewise System Analysis, E. T. Wall. — Sep — 101
Orderly methods for complex system analysis are offered by engineering tensor analysis, which permit separation of a complex problem into parts for complete solution and study. The technique of this form of analysis is described, with examples.

Distributed-Parameter Networks, A. Glaser. — Oct — 105
Networks such as transmission lines, in which the parameters depend upon dimensions and position, cannot be analyzed by lumped-parameter methods. The derivation of distributed-parameter analysis from conventional network concepts is given in detail, with examples. The use of Smith charts for graphical solutions is described.

Physics

Ferromagnetic Domains, P. I. Hershberg. — Jan — 71
An explanation in basic language of the properties of ferromagnetic domains, with examples of applications for many of these properties. Different types of domains, their energy relationships, shapes and formation are discussed within the framework of magnetic theory. Ferromagnetic materials and devices are illustrated by means

of diagrams highlighting properties and characteristics.

Molecular Behavior of Composite Electrical Insulation, C. R. Vail ..... Feb 81
The fundamental nature of materials bears an intimate relationship to their engineering properties. This is particularly true of composite electrical insulating materials and systems, owing to the interaction of various forms of matter—solid, liquid and gaseous—in various configurations and forms. The author first elucidates classical molecular theory, relates molecular behavior to dielectric properties, and then examines composite structures specifically. Illustrations and a bibliography are provided.

The Sound Wave, R. B. Goldman ..... Mar 91
The sources and nature of audible sound are described and the sound wave is analyzed mathematically. Analogies to electromagnetic waves are drawn. Properties of sound such as reflection, diffraction and refraction are described and their physical significances are pointed out. Applications to practical engineering problems concerned with acoustic noise, sonar, ultrasonics and sound reproduction are discussed with examples.

Fluid Mechanics, A. D. Kraus ..... Apr 119
The primary physical laws and definitions governing the static and dynamic behavior of fluids are used to develop effective methods for fluid-system design. The analytical use of energy and continuity equations is illustrated by numerous examples, and the principal methods and devices for fluid-energy measurement are explained.

The Electrical Conductivity of Metals and Alloys, C. M. Jackson and J. G. Dunleavy ..... May 107
A study of the basic aspects of electrical conduction of metallic materials through exploration of atomic and molecular structure and phenomena. The valid older and newer engineering and theoretical approaches to electrical conduction and their adoption for the solution of actual problems in developing and choosing alloys for specific electronic requirements are discussed.

Essentials of Thermodynamics, R. P. Benedict ..... Jul 107
The laws and processes of thermodynamics are developed from fundamental physical principles of energy flow. The concepts of the ideal gas and of ideal cycles are then extended to a study of real processes. Specific detailed analyses of open and closed systems are included.

Permanent Magnets: 1. Basic Behavior of Materials, F. E. Luborsky ..... Jul 100
An introductory review of the origin of ferromagnetism and permanent-magnet behavior. The relationship between magnetic domains and domain-boundary phenomena to effective permanent-magnet materials selection is studied. The anisotropy forces (crystal-, strain-, shape-, and exchange-anisotropy) are reviewed in respect to their effects on properties of permanent magnets.

Permanent Magnets: 2. Examination of Commercial Alloys, F. E. Luborsky ..... Aug 94
A review of the magnetic and physical properties of standard commercially available permanent magnets. Applications to design engineering on the basis of properties are indicated. Inclusion-hardened alloys (magnet steels) and fine-particle magnets (precipitation-hardened and order-hardened alloys) are reported. Standard alloys with their trade names are described in the tables.

Permanent Magnets: 3. Development Materials, F. E. Luborsky ..... Sep 107
A report on the properties and design capabilities of new alloys for permanent-magnet design. The phenomenon of superconductivity in permanent magnets is introduced and exchange anisotropy is discussed. These two scientific breakthroughs lead to significantly different types of permanent magnets.

Principles of Optical Communication, K. W. Otten. Sep 111
The various criteria for transmission of information by using light frequencies are considered. Limitations, advantages and current problems in practical optical communication are clarified by comparison with the more familiar radio communication techniques. The dual concepts of light phenomena are presented to permit discussion of ideal receivers, transmitters and modulators and then their practical counterparts.

Systems

Direct Electrical-Energy Utilization in Metalworking, Staff Report ..... Aug 103
Some of the newest methods, in use or under development, discussed at the 26th Westinghouse Machine Tool Electrification Forum (held in Pittsburgh, June 12-13) include electrohydraulic forming, electrochemical machining, electron-beam welding and cutting, and laser cutting.

COMPONENTS, ELECTRICAL/ELECTRONIC

Evaluation of Conductive Adhesives for Microelectronic Applications, F. Z. Keister ..... Jan 47
An extensive laboratory study of conductive adhesives for intra-connecting microminiature electronic subassemblies. Properties, composition and applications of conductive adhesives are investigated and evaluated. Test procedures are described and related to reliability of the results obtained. Tests include electrical resistivity, shear, tensile and peel strengths, flexibility, adhesion and migration.

Component Reliability in Orbiting Satellites, C. F. Willard ..... Oct 96
The problems in determining component and subsystem reliability in *orbiting* satellites are examined. An analytical method based on telemetry-derived data is presented, and related reliability statistics are given.

Capacitors

Computer-Grade Electrolytic Capacitors—How to Evaluate Them, S. F. Moore, Jr. ..... May 115
Beginning with a description of the materials and techniques involved in their construction, the article tells what the circuit designer should know about aluminum electrolytic capacitors in order to apply them properly. The significance of electrical characteristics is pointed out and the degree of change in these characteristics as it affects stability and life is explained.

Contact Devices

The Electromagnetic Relay, M. Meyers ..... Jan 127
Significant trends in general-purpose, low-level, time-delay and magnetic-reed relays for commercial and military applications are discussed. Pertinent military standards and standardization activities are described briefly. Treatment includes trends in use and design, favorable and unfavorable characteristics of certain types of relays.

A Critical Evaluation of Electrical Control Devices, S. F. Newman ..... Apr 203
To help component manufacturers improve the performance of control devices designed into mass-production equipment, and thereby reduce machine downtime, General Motors Corporation has been testing to destruction various types of relays, limit switches and solenoid valves. The results of a 7-year program are summarized. Present indicated operating performance on highly developed devices is 10 to 50 million faultless operations; the ultimate goal is 100 million.

Improving Contact Reliability in Low-Level Circuits, J. J. McManus ..... May 98
Methods used in telephone, telegraph and facsimile transmission practice are cited with broader application implications. Resistive film forming is related to contact materials. Circuit applications of "wetting" voltages superimposed on data signals to break down dielectric film are illustrated.

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The Small "300-Volt" Relay, J. Zambrzycki ..... In this article an important machinery user reports on laboratory and plant tests of the latest in space-saving industrial control relays for 115-volt circuit application.	May	191
Emphasis on Reliability at Relay Conference, J. R. Riggs ..... A summary report on the Tenth National Conference on Electromagnetic Relays held April 24-26 at Oklahoma State University. Six papers (dealing with various phases of reliability as well as more specific design factors) are reviewed.	Jul	132
Improving Reliability of Microcircuit Connectors, J. R. Anderson and J. B. Saunders ..... A study of the mechanisms of friction and wear in microcircuit connectors presents the results of comparative tests of various films applied to contact metals as boundary lubricants. The data obtained have general application in connectors and contacts used in low-signal-level circuits.	Oct	74
Choppers, Staff Report..... A review of the problems encountered in amplifying a low-level, d-c signal. Direct-coupled amplifiers are discussed, but the chief concern is with the choice between electromechanical choppers and those using semiconductor or photo-sensitive elements. The design of a chopper which is integrated with the amplifier itself is also considered.	Nov	181
First International "Document" on Low-Voltage Contactors, G. W. Heumann..... Significant variations from NEMA standards for industrial control (ICl) are cited in evaluating the document on low-voltage contactors released for publication by the International Electrotechnical Commission at the meeting held in Bucharest, July 1962. Contactors up to 1000 volts a-c and 1200 volts d-c are covered, to be used as a guide by U. S. standards-making bodies.	Dec	143

Embedded Circuits

Design Parameters of Encapsulated Coils, J. A. Foerster ..... A study of magnet-wire insulations and epoxy-resin encapsulations for coil assemblies. The design capabilities and properties of seven insulations and five encapsulants are evaluated for optimum use. Evaluations are undertaken using a systems approach toward materials selection.	Mar	118
Flame-Retardant Epoxy Compounds for Airborne Magnetic Devices, F. T. Parr ..... The performance of flame-retardant epoxy-resin compounds for embedment and impregnation of airborne magnetic components is detailed. Various commercial and specially formulated systems are examined and comparative working data are provided.	Jul	82

Heat Sinks

Heat Sinks for Semiconductor Devices, A. D. Abel ..... A survey of the various types of heat sinks that are available (free convection, forced convection, thermoelectric) with notes as to their selection and use. Lists of typical manufacturers of each type are included.	Jul	193

Magnetic Components

Pulse-Transformer Circuits and Analysis—1, N. R. Grossner ..... Transient conditions rather than the steady state prevail in switching and pulse circuits. Transformers and circuit-analysis methods based on the sine wave are fundamental, of course, but interpretation and transformation are required for application to pulse signals and energy. This two-part article describes and illustrates the necessary mathematical methods for transient analysis, basing the discussion on the fundamental component—the pulse transformer.	Feb	71
Pulse-Transformer Circuits and Analysis—2, N. R. Grossner ..... The second half of this article introduces nonlinearities and distributed capacitance for the analysis of pulse response. The use of equivalent circuits for step-by-step study of pulse-transformer behavior is described.	Mar	80
Computer Magnetics—A Selective Review of Periodical Literature, R. C. Barker..... An annotated guide to papers and articles on the types of non-linear magnetic devices which are so important in computational circuits. Special emphasis is placed on memories and switching circuits.	Mar	74
Design Parameters of Encapsulated Coils, J. A. Foerster ..... A study of magnet-wire insulations and epoxy-resin encapsulations for coil assemblies. The design capabilities and properties of seven insulations and five encapsulants are evaluated for optimum use. Evaluations are undertaken using a systems approach toward materials selection.	Mar	118
A Critical Evaluation of Electrical Control Devices, S. F. Newman..... To help component manufacturers improve the performance of control devices designed into mass-production equipment, and thereby reduce machine downtime, General Motors Corporation has been testing to destruction various types of relays, limit switches and solenoid valves. The results of a 7-year program are summarized. Present indicated operating performance on highly developed devices is 10 to 50 million faultless operations; the ultimate goal is 100 million.	Apr	203
Energy Conversion in Magnetic Devices, P. L. Alger and E. Erdelyi..... Fundamental physical laws are used to develop the performance equations and equivalent circuits for the reactor, transformer and electromagnet. Energy-conversion principles presented in the September 1961 Science & Engineering article "Electromechanical Energy Conversion" are here projected to static magnetic devices.	Jun	79
Flame-Retardant Epoxy Compounds for Airborne Magnetic Devices, F. T. Parr ..... The performance of flame-retardant epoxy-resin compounds for embedment and impregnation of airborne magnetic components is detailed. Various commercial and specially formulated systems are examined and comparative working data are provided.	Jul	82
Heat-Transfer Techniques for Magnetic-Core Components, M. Mark ..... The transformer is used as a typical magnetic component to demonstrate the various practical methods of design for cooling. Conduction, radiation and convection are explored to develop techniques for limiting temperature rise, using both external and internal design elements.	Aug	87
Wide-Band Transformers and Associated Coupling Networks, T. R. O'Meara..... Performance criteria and design objectives for wide-band transformers are defined, and the limitations inherent in conventional configurations and windings indicated. Lumped and distributed-parameter models of transformers and networks are compared. Methods of extending transformer frequency range are outlined. Discussions are augmented by numerous cited references for details.	Sep	80
Magnetic Switching Systems, B. J. O'Neill and L. Weissman..... A description of a newly designed, flexible control system which uses magnetic amplifiers as the switching elements. The system operates on 2000 cps (obtained from an inverter) to decrease size and improve the switching time.	Oct	128

Microcircuit Assemblies

Microelectronic-Interconnection Design, G. L. Branch and R. Y. Scapple ..... A study of the evaluation of materials and construction of a microminiaturized-component	Mar	76

design. Design parameters for ceramic wafers, micro-soldered connections and selection of materials are studied and results given.

Microminiature Logic Modules, S. Schlanger ..... Oct 199
A review of the current trends in design which will influence a system-designer's selection of microminiature modules for digital applications. Included are thin-film and diffused silicon units as well as welded and soldered modules made up of individual microminiature components.

Power Sources

Fuel Cells with Ion-Exchange Electrolytes, A. Dravnieks and J. I. Bregman ..... Jun 135
Of the "exotic" power sources, fuel cells appear to be the most promising as reliable, practicable devices within the near future. Among fuel cells, the type based on the use of ion-exchange-membrane electrolytes appears to have the most compact design. The principles of operation and construction of these devices are described.

Potentiometers and Resistors

Design and Application of Resistance-Wire Heaters, C. Witsken and J. Colten ..... Jan 56
Low-wattage resistance-wire heaters for defrosting, anti-freeze applications, electric blankets and similar applications are examined from the designer's viewpoint. Materials used in such heaters, construction of heaters, application and a design analysis are considered. The design analysis is supplemented by a detailed calibration and test description for heater assemblies. A list of typical values for design parameters is included.

Non-Linear Potentiometers Using Straight-Line Tapers, R. Feit ..... Feb 67
Methods for developing one or, at most, two straight-line tapers for the coil forms of non-linear potentiometers are described. Degrees of accuracy and certain inherent limitations of the methods are explored.

Wirewound Precision Potentiometers, L. T. Peart .. Dec 193
A review of the various specifications which can and should be placed on potentiometers and how well they can and are being met.

Power Supplies

Modular Power Supplies, M. Meyers ..... Jun 189
Developments in modular (component) power supplies are discussed. Supplies discussed are a-c to d-c, d-c to d-c, and d-c to a-c units with d-c outputs to 300 volts and a-c outputs to 200 va.

Designing a Constant-Current Power Supply, J. R. Gately ..... Sep 90
The difficulties which are inherently involved in obtaining a constant-current source are described. A few simple current generators are discussed and then a method of converting a constant-voltage supply to a constant-current unit is proposed.

Choosing a Power Supply, D. R. Hoch ..... Nov 83
A practical guide to the selection of d-c power supplies for large-scale control and computational systems. Included are batteries, unregulated and regulated supplies, and ferroresonant units. The best applications for each type are given.

Semiconductor Devices

Transistor Switches for Low-Level Signals, A. B. Smith ..... Feb 202
Describes the use of the transistor as a relay in a switching circuit (the electronic equivalent of the electromagnetic chopper). Particular importance is placed on the reduction of feedthrough, which consists of either the d-c control signal reflected in the output and/or switching transients.

Applications for Tunnel Diodes, J. H. Phelps..... Mar 60
A survey of the many different types of circuits in which it is now possible to use tunnel diodes successfully. Applications include: fast-switching logic circuits for computers, timing circuits for chronometers, converters for community TV systems and auto radios, and continuous tuners for uhf television.

Diode Testing with Operational Amplifiers, H. C. Grant ..... Apr 101
To measure characteristics of semiconductor diodes, an adjustable source of constant voltage and current is necessary. D-C operational amplifiers may be used as constant-voltage or constant-current generators. The article describes operational-amplifier theory and design, then applies this theory to design of practical test circuits for semiconductor diodes.

Problems and Solutions in Characterizing Transistors, C. D. Simmons ..... May 80
The various ways in which transistors may be specified or characterized are described and their advantages and disadvantages are emphasized. Specification sheets for four of the more important types of transistors are worked out, step by step, to illustrate what proper specifications should accomplish.

A High-Voltage SCR Pulse Inverter, A. A. Vagge .. Jun 126
In an unusual application, the silicon controlled rectifier is used to convert a low-level pulse to a high-level pulse of the same duration. By the use of a "starved anode current," the input pulse is applied to the gate to turn the rectifier both ON and OFF.

Characteristics and Application of PTC Thermistors, J. W. Motto, Jr. ..... Jul 96
The constuction and theory of operation of the thermistor with a positive temperature coefficient are described. Various applications in which the unusual characteristics of the device may be used are illustrated.

Effects of Temperature on High-Frequency Transistors, C. R. Gray and T. C. Sowers ..... Jul 104
The effect of temperature on high-frequency transistor characteristics is examined for Philco MADT devices. A number of characteristic curves are presented from a series of measurements on transistors in test circuits. Transistor power gain, bandwidth, noise figure, power output and frequency shift are related to temperature.

Solid-State Devices for Telemetering, W. B. Allen .. Aug 115
A review of the latest developments in devices for use in telemeter transmitters, particularly those used in space vehicles. New high-power, high-frequency transistors and varactor diodes have considerably increased the efficiency and reliability of such systems.

Measuring Thermal Resistance in Transistors, R. W. Vahle ..... Aug 84
A description of a new method for measuring a very important characteristic in low-power audio and high-frequency transistors. The method provides good accuracy with a minimum of equipment and effort and can be applied to a number of units in an automatic test set-up.

Heat Transfer in Transistors, E. D. Veilleux ..... Sep 97
The mechanics of heat transfer in junction transistors are studied to provide a more intelligent approach to the problem of cooling the device.

Switching Inductive Currents with Power Transistors, R. A. Colclaser ..... Oct 125
A possible cause of transistor failures in high-power switching circuits is the occurrence of instantaneous peak-power dissipations in excess of the maximum allowable rating. Solutions to this problem are discussed in terms of the design of a 4.5-kw, 400-cycle square-wave inverter.

Noise in Transistor Amplifier Circuits, B. Crawford. Nov 63
Sources of electrical noise within a transistor are examined by means of a noise-equivalent circuit, and a general expression for an amplifier noise factor is derived. Equivalent noise bandwidth is defined. Step-by-step methods of making noise measurements in transistor amplifiers are presented.

Subject Classification	Month	Page
Choppers, Staff Report ..... A review of the problems encountered in amplifying a low-level, d-c signal. Direct-coupled amplifiers are discussed, but the chief concern is with the choice between electromechanical choppers and those using semiconductor or photosensitive elements. The design of a chopper which is integrated with the amplifier itself is also considered.	Nov	181
Avalanche-Mode Operation of Silicon Transistors, R. C. Wonson and E. Adler ..... The avalanche phenomenon in semiconductors is described. It is pointed out that the phenomenon gives transistors with the proper design characteristics extremely fast switching times and makes them ideal for use in pulse generators, shapers, etc. Problems of heat dissipation and interconnections are included.	Dec	100
Switches		
Reducing Human Errors by Redesign of Systems Components, M. Freitag..... A critical appraisal, from a human-factors point of view, of available manual control and display components used on instrument panels and consoles built to military specifications. Specific recommendations are given with respect to toggle switches, pushbuttons and selector knobs, along with indicator lights and other identification devices.	Apr	116
Thermoelectric Devices		
Heat Sinks for Semiconductor Devices, A. D. Abel . A survey of the various types of heat sinks that are available (free convection, forced convection, thermoelectric) with notes as to their selection and use. Lists of typical manufacturers of each type are included.	Jul	193
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Fiber Optics Applied to Control and Sensing Devices, E. D. Grim..... The principles of fiber-optic technology are discussed as applied to specific examples of design of devices such as vernier pickoffs, positioning controls, shaft encoders and card and tape readers.	Oct	79
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Moving Cooling Air through High-Resistance Systems, R. G. Hajec..... The choice between positive-displacement air pumps and various types of fans and blowers for cooling electronic assemblies is weighed in terms of the plotted relationship of the dimensionless parameter, specific speed, and static efficiency—plus other factors such as size, weight and cost, particularly in airborne applications.	Oct	100
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Numerical Solutions to Differential Equations, B. H. Liebowitz ..... This article derives those equations which will be used by *digital computers* or desk calculators in generating particular solutions to first- and higher-order differential equations. Emphasis is placed on the character of numerical methods as opposed to analytical methods. Several methods, together with illustrative examples, are presented, plus an appendix on error estimation for polynomial expansions.	Apr	104
The Electrolytic Tank Analog: Design Applications and Limitations, D. L. Amort ..... Derivations are presented to show how the electrolytic tank may be used to obtain solutions of Laplace's equations and functions of a complex variable. Sources of error in a physical-simulation system are analyzed, and the applicability to engineering design and evaluation in field problems is surveyed.	Jul	86
Reducing Wiring Lengths, O. B. Shafer ..... A mathematical process is described which is effective in reducing the amount of wiring between modules in a miniaturized system. For large-scale systems, the process can be programmed for solution on *digital computers*.	Oct	92
DESIGN CONSIDERATIONS		
Electrical Breakdown		
High-Altitude Flashover and Corona Problems—Design Techniques, W. T. Starr..... The first of a two-part series, this article provides summaries of practical techniques used to increase corona and flashover voltages at high altitudes. Design problems discussed relate to transformers, radar antennas and various components. The second article will present a summary and the analysis of experimental data.	May	124
High-Altitude Flashover and Corona Problems—Experimental Data, W. T. Starr ..... A summary and an analysis of experimental data on corona and flashover problems from the existing literature and from unpublished internal company reports. This article rounds out a two-article series, the first of which described specific design techniques for increasing corona and flashover voltages.	Jun	128
Electrical Noise		
Noise in Transistor Amplifier Circuits, B. Crawford. Sources of electrical noise within a transistor are examined by means of a noise-equivalent circuit, and a general expression for an amplifier noise factor is derived. Equivalent noise bandwidth is defined. Step-by-step methods of making noise measurements in transistor amplifiers are presented.	Nov	63
Environmental Effects		
Component Reliability in Orbiting Satellites, C. F. Willard ..... The problems in determining component and subsystem reliability in *orbiting* satellites are examined. An analytical method based on telemetry-derived data is presented, and related reliability statistics are given.	Oct	96
Human Factors		
Man as a Link in a Control Loop, N. D. Diamantides ..... A systematic exposition of experimental techniques employing mathematical models in the study of man's dynamic response when he is functioning as a link in a control system. It is suggested that, with the use of such techniques, the systems engineer should be able to obtain a more precise understanding of human-factors design problems than has been possible through the methods of conventional psychology alone.	Jan	40
Reducing Human Errors by Redesign of Systems Components, M. Freitag..... A critical appraisal, from a human-factors point of view, of available manual control and display components used on instrument panels and consoles built to military specifications. Specific recommendations are given with respect to toggle switches, pushbuttons and selector knobs, along with indicator lights and other identification devices.	Apr	116

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Equipment Design Considerations for Improving Maintenance Procedures, J. M. McKendry and R. E. Stover ..... An examination of (1) the diagnostic problems and decision processes that face the electronic-equipment maintenance technician in his trouble-shooting tasks and (2) the design measures that can be adopted by the equipment design engineer to help the maintenance technician select the most efficient strategies.	Jul	93
Materials Selection Factors		
Wear Characteristics in Nonmetallic Materials, W. A. Glaeser..... A survey of classes of nonmetallic materials and the influence of wear on their selection as materials for design engineering. Materials classes described are: elastomers, ceramics and cermets, sapphire, diamond, plastics, carbon and graphite. Theoretical aspects of wear as related to good design procedure when using nonmetals are investigated and conclusions as to limiting factors are drawn.	Apr	139
Miniaturization		
Reducing Wiring Lengths, O. B. Shafer ..... A mathematical process is described which is effective in reducing the amount of wiring between modules in a miniaturized system. For large-scale systems, the process can be programmed for solution on digital computers.	Oct	92
Reliability		
The "Rate-of-Change" Factor in Reliability, P. Holden ..... Reliability tests of components yield data consisting of parameter values before and after the tests. A method is described for studying the significant rates of change in addition to the absolute values of these parameters.	Jan	53
Relays *vs* Solid-State Devices in Switching Circuits, D. B. Dobson and L. L. Wolff..... A large-scale digital tester, originally designed using only relays in the switching circuits, is analyzed with regard to reliability. The circuits are then re-designed to replace half or all of the relays with solid-state devices. Improvements in reliability are noted at the expense of increased cost and complexity.	Jan	83
Thermal Design for Reliability, R. E. Henry ..... Thermal design of forced-air-cooled electronic equipment to meet a particular failure-rate specification is presented. Importance of basing thermal design on actual component temperatures rather than on ambient temperatures is stressed. A design example is given.	May	87
Component Reliability in Orbiting Satellites, C. F. Willard ..... The problems in determining component and subsystem reliability in *orbiting* satellites are examined. An analytical method based on telemetry-derived data is presented, and related reliability statistics are given.	Oct	96
Matrix Analysis of Reliability for One-Shot Redundant Systems, G. D. Weinstock ..... The methods of matrix algebra are applied to the problem of developing general solutions for the redundant system consisting of modules in series, parallel or series-parallel combinations. The matrix solution is more readily manipulated than ordinary algebraic expressions, but has as its *primary* advantage the suitability to computer programming.	Nov	99
Thermal Design Factors		
Heat Transfer in Transistors, E. D. Veilleux ..... The mechanics of heat transfer in junction transistors are studied to provide a more intelligent approach to the problem of cooling the device.	Sep	97
Moving Cooling Air through High-Resistance Systems, R. G. Hajec ..... The choice between positive-displacement air pumps and various types of fans and blowers for cooling electronic assemblies is weighed in terms of the plotted relationship of the dimensionless parameter, specific speed, and static efficiency—plus other factors such as size, weight and cost, particularly in airborne applications.	Oct	100
HEAT FLOW		
Thermal Design for Reliability, R. E. Henry ..... Thermal design of forced-air-cooled electronic equipment to meet a particular failure-rate specification is presented. Importance of basing thermal design on actual component temperatures rather than on ambient temperatures is stressed. A design example is given.	May	87
Two-Dimensional Transient Heat Flow, R. P. Benedict ..... A problem in two-dimensional heat transfer demonstrates electrical analog and numerical approximation methods of analysis. This is an extension of the principles presented in the December 1961 Science and Engineering article, "Transient Heat Flow."	May	118
Heat-Transfer Techniques for Magnetic-Core Components, M. Mark ..... The transformer is used as a typical magnetic component to demonstrate the various practical methods of design for cooling. Conduction, radiation and convection are explored to develop techniques for limiting temperature rise, using both external and internal design elements.	Aug	87
Moving Cooling Air through High-Resistance Systems, R. G. Hajec..... The choice between positive-displacement air pumps and various types of fans and blowers for cooling electronic assemblies is weighed in terms of the plotted relationship of the dimensionless parameter, specific speed, and static efficiency—plus other factors such as size, weight and cost, particularly in airborne applications.	Oct	100
MATERIALS, ELECTRICAL/ELECTRONIC		
Evaluation of Conductive Adhesives for Microelectronic Applications, F. Z. Keister..... An extensive laboratory study of conductive adhesives for intra-connecting microminiature electronic subassemblies. Properties, composition and applications of conductive adhesives are investigated and evaluated. Test procedures are described and related to reliability of the results obtained. Tests include electrical resistivity, shear, tensile and peel strengths, flexibility, adhesion and migration.	Jan	47
Multifunctional Composite Materials in Environmental Design Problems—1, A. E. Javitz, and H. E. Barkan ..... The first of two articles discussing the properties and application areas of representative composite materials from the standpoint of solving problems of combined environments. Part 1 covers clad metals, metal-clad plastics laminates, and other metallic/nonmetallic rigid and semi-rigid composites.	Nov	104
Multifunctional Composite Materials in Environmental Design Problems—2, A. E. Javitz and H. E. Barkan ..... Second half of a two-part article reviews additional categories of composite materials and examines representative electrical/electronic application areas. Some experimental work is also summarized. Comprehensive property and data charts deal with flexible materials and various metallic and nonmetallic compounds.	Dec	131
Conductor Materials		
Design and Application of Resistance-Wire Heaters, C. Witsken and J. Colten	Jan	56

Low-wattage resistance-wire heaters for defrosting, anti-freeze applications, electric blankets and similar applications are examined from the designer's viewpoint. Materials used in such heaters, construction of heaters, application and a design analysis are considered. The design analysis is supplemented by a detailed calibration and test description for heater assemblies. A list of typical values for design parameters is included.

Microelectronic-Interconnection Design, G. L. Branch and R. Y. Scapple ..... Mar 76
A study of the evaluation of materials and construction of a microminiaturized-component design. Design parameters for ceramic wafers, micro-soldered connections and selection of materials are studied and results given.

Linearity of Precision Resistance Wire, M. P. McConnell ..... Mar 122
Linearity error in resistance wire per unit of length is defined mathematically and methods of making linearity measurements are described. A continuous linearity tester is illustrated which computes and plots the error as a function of length as the wire is passed between contacts of a Wheatstone bridge arm.

The Electrical Conductivity of Metals and Alloys, C. M. Jackson and J. G. Dunleavy ..... May 107
A study of the basic aspects of electrical conduction of metallic materials through exploration of atomic and molecular structure and phenomena. The valid older and newer engineering and theoretical approaches to electrical conduction and their adoption for the solution of actual problems in developing and choosing alloys for specific electronic requirements are discussed.

Improving Reliability of Microcircuit Connectors, J. R. Anderson and J. B. Saunders ..... Oct 74
A study of the mechanisms of friction and wear in microcircuit connectors presents the results of comparative tests of various films applied to contact metals as boundary lubricants. The data obtained have general application in connectors and contacts used in low-signal-level circuits.

Contact Materials

Microelectronic-Interconnection Design, G. L. Branch and R. Y. Scapple ..... Mar 76
A study of the evaluation of materials and construction of a microminiaturized-component design. Design parameters for ceramic wafers, micro-soldered connections and selection of materials are studied and results given.

Electrical Contact Materials—Properties and Selection, E. Freudiger ..... Jun 72
The properties of electrical contact materials are explored for selection in electrical and electromechanical devices. The design parameters for contacts are studied within the framework of the limitations of materials and devices. Basic considerations in the design of contacts are put forth for understanding the operation of contact devices.

Electrical Insulation and Dielectrics

Critical Measurements of Plastics Dielectrics—A Functional Approach, J. M. Schiller ..... Jan 65
An examination of basic materials parameters, standard test methods and related instrumentation in terms of their significance in the prediction of systems performance capability and life. Results of typical tests (both screening and specific) are tabulated to illustrate the effects of various service and processing conditions.

Molecular Behavior of Composite Electrical Insulation, C. R. Vail ..... Feb 81
The fundamental nature of materials bears an intimate relationship to their engineering properties. This is particularly true of composite electrical insulating materials and systems, owing to the interaction of various forms of matter—solid, liquid and gaseous—in various configurations and forms. The author first elucidates classical molecular theory, relates molecular behavior to dielectric properties, and then examines composite structures specifically. Illustrations and a bibliography are provided.

Electrical Insulation—1961-62, A. E. Javitz, Editor Feb 99
A special 48-page research and application report which explores the interdisciplinary position of electrical insulating and dielectric materials in total electrical/electronic systems design. The eight articles which comprise this section include reviews of ceramic insulation, dielectric problems in microelectronic devices, effects of space radiation on insulation, research progress in dielectrics, and current trends in materials and applications, among other subjects.

The "Unified Approach" in Dielectrics—Its Significance in Design Engineering, T. D. Callinan, D. J. Epstein, L. Feinstein, N. M. Bashara, and A. E. Javitz ..... Feb 99
A symposium-in-print elucidating (from several viewpoints) the unified approach in dielectrics, which considers as dielectrics all non-metals in their interaction with electric, magnetic and electromagnetic fields. Practical (and significant) implications in design engineering are drawn.

Ceramic Insulation—A State-of-the-Art Review, H. Thurnauer ..... Feb 102
A report on current research developments in ceramic insulating and dielectric materials. Problem areas in design engineering are introduced and discussed within the framework of structural properties, dielectric properties, thermochemical stability and contact reactions, and processing techniques. An extensive bibliography is included.

Dielectric Problems in Microelectronic Devices, P. White ..... Feb 106
An examination of the special problems created by the application of dielectric materials in microelectronic devices. The problems are discussed from the standpoint of both materials and processing techniques. The effect of techniques on the ultimate properties of the dielectric materials is developed. The responsibility of the circuit designer to evaluate materials and techniques so as to design for optimum performance of the final device is emphasized.

Electrical Insulation—Current Trends in Materials and Applications, Staff Report ..... Feb 111
A preview of the technical program of the Fourth National AIEE-NEMA Electrical Insulation Conference, summarizing salient elements of a wide variety of papers dealing with insulation problems in primary electric equipment and electronic devices (such as power sources and capacitors). Fundamental problems such as thermal endurance and thermal classification are also discussed. Instrumentation and testing needs and criteria are examined.

Space-Radiation Effects on Electrical Insulation and Semiconductors, J. F. Weller, F. J. Campbell and J. W. Kallander ..... Feb 116
A study of outer-space radiation and its effects on organic insulating materials and semiconductors. The nature of Van Allen Belt radiation, cosmic rays and solar flares with types of radiation damage and effects on structure of materials, together with results of laboratory tests and missile shots. The mechanism of damage is reviewed.

Research Progress in Dielectrics—1961, A. E. Javitz ..... Feb 127
An on-the-spot review and interpretation of the 1961 National Academy of Sciences-National Research Council Conference on Electrical Insulation. The review covers a wide span of activity, including work in electrical discharges and tracking, dielectric properties of glasses, gamma-radiation-induced effects, space charges studies, breakdown phenomena, dielectric relaxation and cable insulation problems.

Dielectric Constant and Loss—Their Significance

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in Insulation Selection, A. H. Sharbaugh ..... A basic definition of dielectric constant and loss factor for electrical insulating materials based on macroscopic electrostatic theory and related to the atomic and molecular structure of the material. Discussion includes dependence of measured values on prevailing temperature and frequency. Further discussion includes measurement techniques at various frequencies.	Feb	146
Insulation Applications Problems, A. J. Warner .... A review of recent pertinent literature concerned with applications problems in transformers, switchgear, motors and generators, and magnet wire. A bibliography of 32 references is included.	Feb	165
Design Parameters of Encapsulated Coils, J. A. Foerster ..... A study of magnet-wire insulations and epoxy-resin encapsulations for coil assemblies. The design capabilities and properties of seven insulations and five encapsulants are evaluated for optimum use. Evaluations are undertaken using a systems approach toward materials selection.	Mar	118
Electrical Insulation Tracking—A Design-Engineering Problem, K. N. Mathes and E. J. McGowan ..... Progressive electrical failure of insulation surfaces in the presence of contaminants is a major problem that cannot be solved by geometry of design and protective devices. This article reviews conditions of failure, tests for evaluating track resistance, and types of *track-resistant* plastics. Test data are provided.	Apr	146
Using Fast-Pulse Techniques To Study Insulating Materials, W. E. Spear ..... A study of fast-pulse techniques used in the investigation of semiconductor materials with relatively high resistivity may be adapted to the study of insulating solids, including organic insulators.	May	94
High-Altitude Flashover and Corona Problems—Design Techniques, W. T. Starr..... The first of a two-part series, this article provides summaries of practical techniques used to increase corona and flashover voltages at high altitudes. Design problems discussed relate to transformers, radar antennas and various components. The second article presents a summary and the analysis of experimental data.	May	124
Ceramic Radomes—Materials and Design, D. Noll. Development of the ceramic radome is a part of the solution to the problem of protection and efficient operation of highly selective and complex airborne electronic compbnents and systems. This article explores the design parameters and materials properties of ceramic radomes within the limitations of electrical considerations and environmental phenomena. Some of the properties of materials are further illustrated by graphs and charts.	Jun	88
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Flame-Retardant Epoxy Compounds for Airborne Magnetic Devices, F. T. Parr ..... The performance of flame-retardant epoxy-resin compounds for embedment and impregnation of airborne magnetic components is detailed. Various commercial and specially formulated systems are examined and comparative working data are provided.	Jul	82
Pressure-Sensitive-Adhesive Electrical Tapes, I. Katz..... This review of p.s.a. electrical tapes for primary and secondary insulation applications (also for mechanical functions such as holding and banding, as well as for circuit identification) is based on various types covered by applicable MIL and Federal Specifications.	Aug	181
Overload Characteristics of Enameled Magnet Wire, C. F. Hunt, A. F. Fitzhugh, and A. H. Markhardt..... Various types of magnet-wire insulation (including several new formulations) have been tested by a new "burnout" method to obtain comparative values of performance under severe overload conditions. Test data are given and the test procedure is described.	Sep	131
Thermal Changes in Magnet-Wire Systems, A. F. Fitzhugh and J. R. Taylor ..... Temperature effects on the 60-cycle properties of 14 different types of magnet-wire coatings have been investigated. The results are reported and discussed.	Dec	104

Magnetic Materials

Ferromagnetic Domains, P. I. Hershberg ..... An explanation in basic language of the properties of ferromagnetic domains, with examples of applications for many of these properties. Different types of domains, their energy relationships, shapes and formation are discussed within the framework of magnetic theory. Ferromagnetic materials and devices are illustrated by means of diagrams highlighting properties and characteristics.	Jan	71
Permanent Magnets: 1. Basic Behavior of Materials, F. E. Luborsky ..... An introductory review of the origin of ferromagnetism and permanent-magnet behavior. The relationship between magnetic domains and domain-boundary phenomena to effective permanent-magnet materials selection is studied. The anisotropy forces (crystal-, strain-, shape- and exchange-anisotropy) are reviewed in respect to their effects on properties of permanent magnets.	Jul	100
Permanent Magnets: 2. Examination of Commercial Alloys, F. E. Luborsky ..... A review of the magnetic and physical properties of standard commercially available permanent magnets. Applications to design engineering on the basis of properties are indicated. Inclusion-hardened alloys (magnet steels) and fine-particle magnets (precipitation-hardened and order-hardened alloys) are reported. Standard alloys with their trade names are described in the tables.	Aug	94
Permanent Magnets: 3. Developmental Materials, F. E. Luborsky..... A report on the properties and design capabilities of new alloys for permanent-magnet design. The phenomenon of superconductivity in permanent magnets is introduced and exchange anisotropy is discussed. These two scientific breakthroughs lead to significantly different types of permanent magnets.	Sep	107

Semiconductor Materials

Using Fast-Pulse Techniques To Study Insulating Materials, W. E. Spear ..... A study of fast-pulse techniques used in the investigation of semiconductor materials with relatively high resistivity may be adapted to the study of insulating solids, including organic insulators.	May	94
Materials for Engineering Thermoelectric Devices, James W. Davisson and Joseph Pasternak..... A status report on progress in thermoelectricity provides (1) an examination of the characteristics of the available as well as experimental thermoelectric materials, (2) a summary of developments in thermoelectric devices, and (3) a cost-efficiency analysis of thermoelectric materials.	Aug	128

MATERIALS, MECHANICAL/STRUCTURAL

Adhesives

Adhesives for Extreme-Low-Temperature Applications, J. Hertz.....	Sep	93

Suitable adhesives can be effectively used to bond essential component elements in electrical/electronic devices that operate in cryogenic media or are exposed to cryogenic environments. Aerospace and missile circuits are outstanding application areas. This report summarizes available data on adhesive materials and systems that can be used under cryogenic conditions.

Composite Materials

Multifunctional Composite Materials in Environmental Design Problems—1, A. E. Javitz and H. E. Barkan ..... Nov 104
The first of two articles discussing the properties and application areas of representative composite materials from the standpoint of solving problems of combined environments. Part 1 covers clad metals, metal-clad plastics laminates, and other metallic/nonmetallic rigid and semi-rigid composites.

Multifunctional Composite Materials in Environmental Design Problems—2, A. E. Javitz and H. E. Barkan ..... Dec 131
This second half of a two-part article reviews additional categories of composite materials and examines representative electrical/electronic application areas. Some experimental work is also summarized. Comprehensive property and data charts deal with flexible materials and various metallic and nonmetallic compounds.

Metals

Microelectronic-Interconnection Design, G. L. Branch and R. Y. Scapple ..... Mar 76
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Electrical Contact Materials—Properties and Selection, E. Freudiger ..... Jun 72
The properties of electrical contact materials are explored for selection in electrical and electromechanical devices. The design parameters for contacts are studied within the framework of the limitations of materials and devices. Basic considerations in the design of contacts are put forth for understanding the operation of contact devices.

Nonmetallic Materials

Wear Characteristics in Nonmetallic Materials, W. A. Glaeser ..... Apr 139
A survey of classes of nonmetallic materials and the influence of wear on their selection as materials for design engineering. Materials classes described are: elastomers, ceramics and cermets, sapphire, diamond, plastics, carbon and graphite. Theoretical aspects of wear as related to good design procedure when using nonmetals are investigated and conclusions as to limiting factors are drawn.

Ceramic Radomes—Materials and Design, D. Noll. Jun 88
Development of the ceramic radome is a part of the solution to the problem of protection and efficient operation of highly selective and complex airborne electronic components and systems. This article explores the design parameters and materials properties of ceramic radomes within the limitations of electrical considerations and environmental phenomena. Some of the properties of materials are further illustrated by graphs and charts.

MOTORS

All Classifications

Two-Speed, Non-Excited Synchronous Motors, W. A. Andersen and J. E. Haegh ..... Jan 60
The reluctance synchronous motor can now offer two-speed operation and torque comparable to an induction motor of the same size. The magnetic-circuit design refinements leading to these improvements are discussed in detail.

Fractional-Horsepower

Commutation in FHP Universal Motors, C. W. Dickin-Zangger ..... Jun 138
Optimal performance, physical size and cost of commutator motors depend largely on communication factors. Guidance is offered here to the primary aspects of brush and commutator behavior and life, with explanation of the physical principles involved.

Small Motors, Staff Report ..... Sep 203
The term "small motors" necessarily covers a wide spectrum of performance, physical structure and application. Standardization is not well established, and it is difficult to translate equipment and system requirements into small-motor specifications. These and other problems and trends are discussed by small-motor users and designers.

Performance Analysis of Universal Motors, C. W. Dickin-Zangger ..... Dec 127
Comparison of various designs of universal motors for particular applications can best be made by evaluating their energy distributions. The complexity of such motors makes a combination of measurement and analysis necessary for the evaluation. A method is presented here, with illustrative data.

Special

Hydraulic Stepping Motors, D. G. O'Brien ..... Apr 91
A review of the advantages to be gained by using incremental stepping devices in control systems, particularly hydraulically powered units. Some of the latest developments in the design and application of these devices are described.

Small Motors, Staff Report ..... Sep 203
The term "small motors" necessarily covers a wide spectrum of performance, physical structure and application. Standardization is not well established, and it is difficult to translate equipment and system requirements into small-motor specifications. These and other problems and trends are discussed by small-motor users and designers.

PRODUCTION AND ASSEMBLY TECHNIQUES

Miscellaneous

Direct Electrical-Energy Utilization in Metalworking, Staff Report ..... Aug 103
Some of the newest methods, in use or under development, discussed at the 26th Westinghouse Machine Tool Electrification Forum (held in Pittsburgh, June 12-13) include electrohydraulic forming, electrochemical machining, electron-beam welding and cutting, and laser cutting.

SYSTEMS

Amplifier Circuits

Noise in Transistor Amplifier Circuits, B. Crawford ..... Nov 63
Sources of electrical noise within a transistor are examined by means of a noise-equivalent circuit, and a general expression for an amplifier noise factor is derived. Equivalent noise bandwidth is defined. Step-by-step methods of making noise measurements in transistor amplifiers are presented.

Negative Feedback in Voltage Amplifiers, R. R. Jennings ..... Dec 80
Discusses the impedance-transforming properties of negative feedback when applied to voltage amplifiers. The proper application of feedback makes it possible to obtain a closed-loop circuit

that is either a current, transconductance, or transresistance amplifier.

Analysis

Operational Calculus, C. K. Hager ..... Jun 93
Includes: Fourier series and the Fourier integral, unilateral and bilateral Laplace transforms, the inverse Laplace transform, and their mathematical properties. Plus: tables of transforms, the convolution integral and the *n*th order impulse function, physical systems, the classical and operational approaches to linear systems, the transfer function and the impulse response in *linear systems*. Applications to networks.

Piecewise System Analysis, E. T. Wall ..... Sep 101
Orderly methods for complex system analysis are offered by engineering tensor analysis, which permit separation of a complex problem into parts for complete solution and study. The technique of this form of analysis is described, with examples.

Matrix Analysis of Reliability for One-Shot Redundant Systems, G. D. Weinstock ..... Nov 99
The methods of matrix algebra are applied to the problem of developing general solutions for the redundant system consisting of modules in series, parallel or series-parallel combinations. The matrix solution is more readily manipulated than ordinary algebraic expressions, but has as its *primary* advantage the suitability to computer programming.

Analog Analysis Using Stochastic Processes, B. D. Van Deusen ..... Nov 115
Systems which can be analyzed using analog-computer simulation are defined, with particular emphasis on those systems whose inputs are time variant and which cannot be easily predetermined. In the latter cases, stochastic, or statistical, analysis is necessary. Statistical terms are defined and the computer circuits needed to simulate statistical processes are given.

Communication

Time-Sharing Technique in Electro-Cybernetics, J. W. Hannah ..... Mar 113
Principles and techniques of time sharing in communication systems. Transistors as gate switches and capacitors as energy storers. Description of simple shunt-capacitor circuit and symmetrical filter switching network in time sharing and their subsequent energy losses due to the redistribution of charges.

Principles and Techniques of Modulation, J. Hupert ..... Apr 94
The processing of a signal into a convenient region of frequency space to give desired transmission. Concepts of time and frequency spectra. Single- and multi-tone amplitude and angular modulation and their respective resolutions into Fourier and Bessel sidebands. Noise in modulation. Suppressed carrier modulation. Pulse-code modulation and sampling. Frequency- and time-division multiplexing.

Improving Contact Reliability in Low-Level Circuits, J. J. McManus ..... May 98
Methods used in telephone, telegraph and facsimile transmission practice are cited with broader application implications. Resistive film forming is related to contact materials. Circuit applications of "wetting" voltages superimposed on data signals to break down dielectric film are illustrated.

Principles and Techniques of Single-Sideband Modulation, W. B. Bruene ..... Jul 123
Discussion of the practices and advantages of SSB r-f transmission, including the nature and requirements of SSB, multiplexing systems, bandwidth, power and linearity. Discussions of SSB transmitters, receivers and transceivers lead to a general examination of basic SSB circuits. SSB signal modulation is compared to AM, and its present position in commercial, military and amateur communications is investigated.

Principles of Optical Communication, K. W. Otten. Sep 111
The various criteria for transmission of information by using light frequencies are considered. Limitations, advantages and current problems in practical optical communication are clarified by comparison with the more familiar radio communication techniques. The dual concepts of light phenomena are presented to permit discussion of ideal receivers, transmitters and modulators and then their practical counterparts.

Digital-Data Transmission over Voice Channels, M. E. Jazbutis, C. F. Halm, and J. T. Kries ... Nov 123
A method of transmitting digital data over telephone transmission lines is proposed. The companding technique of converting binary pulses into audio-frequency signals is described. Binary pulses at the rate of 2400 bits per sec are converted into an a-f signal whose essential components require a bandwidth of only 1080 cps.

Pulse-Code Modulation, J. S. Mayo ..... Nov 87
Sampling theory and the basic characteristics of pulse-code modulation are introduced, leading to a consideration of advantages and limitations of the principle. Various pulse-coding systems are compared, and reference-time, compression and multiplexing techniques and problems are discussed. The present state-of-the-art is projected to visualize future developments.

Application and Generation of Audio-Frequency Random Noise, J. T. Broch ..... Dec 84
Various forms of random noise are defined. Some measuring arrangements for the determination of frequency spectra and amplitude distributions of fluctuating signals are described. The similarities between amplitude density curves for the latter and those for "natural sounds" indicate that random noise is very useful as a sound source in acoustic and electro-acoustic measurements.

Control

Man as a Link in a Control Loop, N. D. Diamantides ..... Jan 40
A systematic exposition of experimental techniques employing mathematical models in the study of man's dynamic response when he is functioning as a link in a control system. It is suggested that, with the use of such techniques, the systems engineer should be able to obtain a more precise understanding of human-factors design problems than has been possible through the methods of conventional psychology alone.

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Linear and Nonlinear Circuits: A Selective Review of the Literature, J. J. Hupert ..... Jan 87
A critical and progressive guide to contemporary reference and text material in circuit analysis and synthesis. Linear and active network theory, lumped networks, and nonlinear circuit concepts are described, and recommended book and periodical sources are discussed.

Solving Servo Cubic Equations, J. P. Cummings ... Feb 198
In many complicated servo systems, the transfer function takes the form of a cubic equation, which is not as easily solved as the usual quadratic. Presented here is a straightforward formula for solving the cubic equation when one of the roots is $s = -a$.

Transistor Switches for Low-Level Signals, A. B. Smith ..... Feb 202
Describes the use of the transistor as a relay in a switching circuit (the electronic equivalent of the electromagnetic chopper). Particular importance is placed on the reduction of feedthrough, which consists of either the d-c control signal reflected in the output and/or switching transients.

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Analog-to-Digital Converters, P. P. Fischer ..... A survey of current problems in the design and application of converters which convert analog voltages to digital signals. Types of quantizing systems are described and their advantages and disadvantages are pointed out. Other important characteristics to look for when choosing a converter are discussed, with a guide to what is currently available without going to special designs.	Mar	165
Reducing Human Errors by Redesign of Systems Components, M. Freitag..... A critical appraisal, from a human-factors point of view, of available manual control and display components used on instrument panels and consoles built to military specifications. Specific recommendations are given with respect to toggle switches, pushbuttons and selector knobs, along with indicator lights and other identification devices.	Apr	116
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Designing Counting Circuits with Static-Switching Blocks, J. J. Eckl and C. F. Meyer ..... Standard NOR elements using transistor logic are used to design various types of counting circuits for industrial control systems. Circuits can count up or down or both. A circuit for decoding for decimal readout is also given.	May	133
A High-Voltage SCR Pulse Inverter, A. A. Vagge .. In an unusual application, the silicon controlled rectifier is used to convert a low-level pulse to a high-level pulse of the same duration. By the use of a "starved anode current," the input pulse is applied to the gate to turn the rectifier both ON and OFF.	Jun	126
Non-Linear Feedback Control Systems: 1. Non-Linearities and Integrable Systems, E. Levinson ..... The first part of a six-article series on the design and analysis of non-linear systems. Since all physical systems contain one or more non-linearities to some degree, the analysis of servos by linear processes is merely the creation of a mathematical model. This series will acquaint the reader with the various techniques which are available to analyze the non-linear system as it truly exists.	Jul	76
Hydraulic-Control-System Analysis, H. Diamond and S. Fenster..... Valve-controlled servomechanisms are analyzed as an introduction to the study of hydraulic and pneumatic control systems. Factors influencing gain, response speed, accuracy, and stability are considered. Basic expressions for power rating and efficiency are developed, and certain practical considerations in valve and system design are discussed.	Aug	76
Non-Linear Feedback Control Systems: 2. Phase-Plane Analysis, E. Levinson ..... In this second part of a series on non-linear analysis and design, the method of phase-plane analysis is described and illustrated by applying it to some practical systems. Phase-plane analysis is a graphical technique which is applicable primarily to systems with second-order, non-linear differential equations.	Aug	118
Non-Linear Feedback Control Systems: 3. Describing Functions and Frequency Analysis, E. Levinson..... The third article of a six-part series on non-linear system analysis. The method of describing-function analysis is explained and illustrated with examples. This method is extremely important in determining system stability. It is comparable to the use of transfer-function analysis in linear systems.	Sep	136
Fiber Optics Applied to Control and Sensing Devices, E. D. Grim..... The principles of fiber-optic technology are discussed as applied to specific examples of design of devices such as vernier pickoffs, positioning controls, shaft encoders and card and tape readers.	Oct	79
Hydraulic Flow Controls and Actuators, H. Diamond and S. Fenster..... Primary flow-control and actuator devices for hydraulic control systems are considered and their characteristics compared for application guidance. Flow characteristics and operation of pumps, valves, cylinders and motors (and of their various combinations) are included.	Oct	84
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Non-Linear Feedback Control Systems: 4. Miscellaneous Analysis Methods, E. Levinson ..... Preceding articles have discussed integrable types of non-linear systems and have described the phase-plane and describing-function methods of analysis. In this part, several additional analysis methods for the solution of certain types of non-linearities are discussed.	Oct	131
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Non-Linear Feedback Control Systems: 5. Compensation for Unwanted Non-Linearities, E. Levinson..... Previous articles in this series have presented various tools and techniques for the analysis of non-linear systems. In this article, the more common incidental non-linearities are discussed and methods of compensating for their undesirable effects (using the techniques previously given) are described.	Nov	71
Choosing a Power Supply, D. R. Hoch..... A practical guide to the selection of d-c power supplies for large-scale control and computational systems. Included are batteries, unregulated and regulated supplies, and ferroresonant units. The best applications for each type are given.	Nov	83
Analog Analysis Using Stochastic Processes, B. D. Van Deusen..... Systems which can be analyzed using analog-computer simulations are defined, with particular emphasis on those systems whose inputs are time variant and which cannot be easily predetermined. In the latter cases, stochastic, or statistical, analysis is necessary. Statistical terms are defined and the computer circuits needed to simulate statistical processes are given.	Nov	115
Non-Linear Feedback Control Systems: 6. Intentional Non-Linear Systems, E. Levinson..... Several intentional or purposeful non-linearities that have been employed in feedback control systems are described. These are non-linearities purposely inserted to achieve better performance, in one way or another, over that which would be possible using only linear elements. The relay servos described are the well-known "ON-OFF" or "bang-bang" systems.	Dec	89

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Relays *vs* Solid-State Devices in Switching Circuits, D. B. Dobson and L. L. Wolff..... A large-scale digital tester, originally designed using only relays in the switching circuits, is analyzed with regard to reliability. The circuits are then re-designed to replace half or all of the relays with solid-state devices. Improvements in reliability are noted at the expense of increased cost and complexity.	Jan	83

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Binary Logic Functions, J. Deliyannides and R. T. Byerly ..... A detailed explanation of how a binary digital machine functions. Begins with an explanation of codes and proceeds through the basic circuits, such as flip-flops, gates, registers, and counters, to the complete block diagram of a large-scale computer.	Feb	58
Computer Magnetics—A Selective Review of Periodical Literature, R. C. Barker..... An annotated guide to papers and articles on the types of non-linear magnetic devices which are so important in computational circuits. Special emphasis is placed on memories and switching circuits.	Mar	74
Analog-to-Digital Converters, P. P. Fischer..... A survey of current problems in the design and application of converters which convert analog voltages to digital signals. Types of quantizing systems are described and their advantages and disadvantages are pointed out. Other important characteristics to look for when choosing a converter are discussed, with a guide to what is currently available without going to special designs.	Mar	165
Digital Logic Circuits—Their Specification and Use, J. E. Armstrong, Jr. ..... An explanation of some of the terms used in specifying digital logic modules: clock rate, transient times, orders of logic. The lack of industry-wide standards on these components makes it necessary to have a good understanding of what is meant when the supplier states these various characteristics for his units.	Apr	88
Designing Counting Circuits with Static-Switching Blocks, J. J. Eckl and C. F. Meyer ..... Standard NOR elements using transistor logic are used to design various types of counting circuits for industrial control systems. Circuits can count up or down or both. A circuit for decoding for decimal readout is also given.	May	133
Microminiature Logic Modules, S. Schlanger..... A review of the current trends in design which will influence a system designer's selection of microminiature modules for digital applications. Included are thin-film and diffused silicon units as well as welded and soldered modules made up of individual microminiature components.	Oct	199
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Electrical Insulation Tracking—A Design-Engineering Problem, K. N. Mathes and E. J. McGowan ..... Apr 146
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Using Fast-Pulse Techniques To Study Insulating Materials, W. E. Spear ..... May 94
A study of fast-pulse techniques used in the investigation of semiconductor materials with relatively high resistivity may be adapted to the study of insulating solids, including organic insulators.

Thermal Changes in Magnet-Wire Systems, A. F. Fitzhugh and J. R. Taylor ..... Dec 104
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Application and Generation of Audio-Frequency Random Noise, J. T. Broch ..... Dec 84
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Adhesives	Materials, Mechanical/Structural
Automatic Assembly	Production and Assembly Techniques
B	
Batteries	Components, Electrical/Electronic
Bearings	Components, Mechanical/Structural
Boolean Algebra	Science & Engineering *(Mathematics)*
Brushes	Components, Electrical/Electronic *(Contact Devices)*
C	
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Casting Resins	Materials, Electrical/Electronic *(Electrical Insulation and Dielectrics)*
Castings	Materials, Mechanical/Structural *(Metals)*
Ceramic Dielectrics	Materials, Electrical/Electronic *(Electrical Insulation and Dielectrics)*
Ceramic-Metals	Materials, Mechanical/Structural *(Composite Materials)*
Cements	Materials, Mechanical/Structural *(Adhesives)*
Circuit Analysis	Science & Engineering *(Network Analysis)*
Circuit Breakers	Components, Electrical/Electronic *(Protective Devices)*
Clad Metals	Materials, Mechanical/Structural *(Metals)*
Coaxial Cable	Components, Electrical/Electronic *(Wire and Cable)*
Commutators	Components, Electrical/Electronic *(Contact Devices)*
Component Failure	Design Considerations *(Reliability)*
Component Testing	Test and Measurement
Composite Materials	Materials, Mechanical/Structural
Computer Design	Systems *(Modular Subsystems)*
Conductive Plastics	Materials, Electrical/Electronic *(Conductor Materials)*
Conductive Rubber	Materials, Electrical/Electronic *(Conductor Materials)*
Conductor Materials	Materials, Electrical/Electronic
Connections	Production and Assembly Techniques *(Soldering and Solderless Techniques)*
Connectors	Components, Electrical/Electronic *(Wiring Devices)*
Contact Devices	Components, Electrical/Electronic
Contact Materials	Materials, Electrical/Electronic *(Contact Materials)*
Control Instruments	Systems *(Control)*
Cooling	Heat Flow
Corona Effects	Test and Measurement *(Materials)*
D	
Delay Lines	Components, Electrical/Electronic *(Storage Devices)*
Diodes	Components, Electrical/Electronic *(Semiconductor Devices)*
Drive Elements	Systems *(Drives)*, also Components, Mechanical/Structural
E	
Elastomers	Materials, Mechanical/Structural *(Nonmetallic Materials)*
Electrical Drives	Systems *(Drives)*
Electrical Insulation and Dielectrics	Materials, Electrical/Electronic
Electrodeposited Coatings	Materials, Mechanical/Structural *(Protective Coatings)*
Electronic Apparatus Design	Product Design Case History
Electron Tubes	Components, Electrical/Electronic
Embedded Circuits and Componets	Production and Assembly Techniques
Encapsulation	Production and Assembly Techniques *(Embedded Circuits and Components)*
Engineering Psychology	Design Considerations *(Human Factors)*
Environmental Effects	Design Considerations
Environmental Tests	Test and Measurement *(Environmental)*
Equipment Failure	Design Considerations *(Reliability)*
F	
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Felt	Materials, Mechanical/Structural *(Nonmetallic Materials)*
Ferrites	Materials, Electrical/Electronic *(Magnetic Materials)*
Finishes	Materials, Mechanical/Structural *(Protective Coatings)*
Flexible Insulation	Materials, Electrical/Electronic *(Electrical Insulation and Dielectrics)*
Fungicidal Treatment	Materials, Mechanical/Structural *(Protective Coatings)*
Fuses	Components, Electrical/Electronic *(Protective Devices)*
G	
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Gaskets	Components, Mechanical/Structural *(Seals and Gaskets)*
Gearmotors	Motors *(Special)*
Gears and Pinions	Components, Electrical/Electronic, also Systems *(Mechanical)*
Glass Dielectrics	Materials, Electrical/Electronic *(Electrical Insulation and Dielectrics)*
H	
Hermetic Sealing	Production and Assembly Techniques
Hookup Wire	Components, Electrical/Electronic *(Wire and Cable)*
Housings	Components, Mechanical/Structural
Human Factors Engineering	Design Considerations
Humidity Effects	Design Considerations *(Environmental Effects)*
I	
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Inductors	Components, Electrical/Electronic *(Magnetic Components)*
Industrial Machinery Design	Product Design Case History
Instrument Applications	Test and Measurement
Instrument Design	Product Design Case History, also Instruments and Test Equipment *(Design)*
Instrument Generators	Components, Electrical/Electronic *(Transducers)*
Insulation Testing	Test and Measurement *(Materials)*
International Standards	Specifications and Standards
L	
Laminates, Plastics	Materials, Electrical/Electronic *(Electrical Insulation and Dielectrics)*
Liquid Dielectrics	Materials, Electrical/Electronic *(Electrical Insulation and Dielectrics)*
Lubricants	Materials, Mechanical/Structural *(Nonmetallic Materials)*

Subject	*Classification*
M	
Magnetic Amplifiers	Systems (*Control*) also Components, Electrical/Electronic (*Magnetic Components*)
Magnetic Core Memories	Components, Electrical/Electronic (*Storage Devices*)
Magnetic Materials	Materials, Electrical/Electronic
Magnetic Recording	Components, Electrical/Electronic (*Transducers*), also Systems (*Recording*)
Magnet Wire	Components, Electrical/Electronic (*Wire and Cable*)
Maintainability	Design Considerations
Materials Testing	Test and Measurement
Mechanical Drives	Systems (*Mechanical*) also Components, Mechanical/Structural (*Drive Elements*)
Metalized Parts	Materials, Mechanical/Structural (*Composite Materials*)
Metal-Plastics Sheet	Materials, Mechanical/Structural (*Composite Materials*)
Metals	Materials, Mechanical/Structural
Meters, Panel-Type	Components, Electrical/Electronic
Microcircuit Assemblies	Components, Electrical/Electronic
Miniaturization	Design Considerations
Modular Construction	Design Considerations (*Miniaturization*)
N	
Nomographs	Science & Engineering (*Mathematics*)
Nonmetallic Materials	Materials, Mechanical/Structural
Nuclear Radiation Effects	Design Considerations (*Environmental Effects*)
P	
Packaging, Electronic	Production and Assembly Techniques
Pickups, Electrical	Components, Electrical/Electronic (*Transducers*)
Plastics, Fabricated	Materials, Mechanical/Structural (*Nonmetallic Materials*)
Plastics, Insulation	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
Plastics, Molded	Materials, Mechanical/Structural (*Nonmetallic Materials*)
Plated Coatings	Materials, Mechanical/Structural (*Protective Coatings*)
Procelain Enamel	Materials, Mechanical/Structural (*Protective Coatings*)
Potentiometers	Components, Electrical/Electronic
Potting	Production and Assembly Techniques (*Embedded Circuits and Components*)
Powder Metal Parts	Materials, Mechanical/Structural (*Metals*)
Power Generators	Systems (*Drives*)
Printed Circuits	Components, Electrical/Electronic
Printed Wiring	Production and Assembly Techniques
Printed Wiring Board	Components, Electrical/Electronic (*Printed Circuits*)
Production Tests	Test and Measurement
Protective Coatings	Materials, Mechanical/Structural
Protective Devices	Components, Electrical/Electronic
Q	
Quality Control	Test and Measurement
R	
Radio Noise and Interference	Design Considerations
Recording Instruments	Instruments and Test Equipment, also Systems (*Recording*)
Rectifiers	Components, Electrical/Electronic (*Semiconductor Devices*)
Relays	Components, Electrical/Electronic (*Contact Devices*)
Reliability	Design Considerations
Resistance Wire	Materials, Electrical/Electronic (*Conductor Materials*)
Resistors	Components, Electrical/Electronic
Rigid Insulation	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
S	
Sealants	Materials, Mechanical/Structural (*Adhesives*)
Seals and Gaskets	Components, Mechanical/Structural
Semiconductor Devices	Components, Electrical/Electronic
Sensing Elements	Components, Electrical/Electronic (*Transducers*)
Servos	Systems (*Control*)
Sheet Metals	Materials, Mechanical/Structural (*Metals*)
Shielding Devices	Components, Electrical/Electronic
Shock and Vibration	Design Considerations (*Environmental Effects*)
Shock and Vibration Isolators	Components, Mechanical/Structural
Slip Rings	Components, Electrical/Electronic (*Contact Devices*)
Sockets	Components, Electrical/Electronic (*Wiring Devices*)
Soldering and Solderless Techniques	Production and Assembly Techniques
Solenoids	Components, Electrical/Electronic (*Magnetic Components*)
Springs	Components, Mechanical/Structural
Storage Devices	Components, Electrical/Electronic
Strength and Weight Factors	Design Considerations
Switches	Components, Electrical/Electronic
Systems, Testing	Test and Measurement
T	
Temperature Limits	Test and Measurement
Terminals	Components, Electrical/Electronic (*Wiring Devices*)
Test Equipment	Test and Measurement
Thermal and Acoustical Insulation	Materials, Mechanical/Structural
Thermal Design Factors	Design Considerations
Thermal Dissipation	Heat Flow
Thermistors	Components, Electrical/Electronic (*Semiconductor Devices*)
Thermostats	Components, Electrical/Electronic (*Transducers*)
Transducers	Components, Electrical/Electronic
Transformers	Components, Electrical/Electronic (*Magnetic Components*)
Transistors	Components, Electrical/Electronic (*Semiconductor Devices*)
U	
Unitized Construction	Production and Assembly Techniques
V	
Varnishes, Insulating	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
W	
Waveguides	Components, Electrical/Electronic (*Microwave Components*)
Wire and Cable	Components, Electrical/Electronic
Wire Enamel and Insulation	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
Wiring Devices	Components, Electrical/Electronic
Wiring Harness	Components, Electrical/Electronic (*Wire and Cable*)

Editorial Subject Classification

Science & Engineering

- Chemistry of Materials
- Dielectrics
- Mathematics
- Network Analysis
- Physics
- Systems

Components, Electrical/Electronic

- Batteries
- Capacitors
- Contact Devices
- Electron Tubes
- Embedded Circuits
- Magnetic Components
- Meters, Panel-type
- Microcircuit Assemblies
- Microwave Components
- Motors (classified separately)
- Potentiometers and Resistors
- Power Sources
- Power Supplies
- Printed Circuits
- Protective Devices
- Semiconductor Devices
- Shielding Devices
- Storage Devices
- Switches
- Thermoelectric Devices
- Transducers
- Wire and Cable
- Wiring Devices

Components, Mechanical/Structural

- Bearings
- Drive Elements
- Fasteners
- Gears
- Housings
- Seals and Gaskets
- Shock and Vibration Isolators
- Springs

Computing Machines (see also: Systems, Digital)

- Applications

Design Considerations

- Cost Factors
- Electrical Noise
- Environmental Effects
- Human Factors
- Maintainability
- Materials Selection Factors
- Miniaturization
- Radio Noise and Interference
- Reliability
- Strength and Weight Factors
- Thermal Design Factors

Heat Flow

Instruments and Test Equipment

- Design

Materials, Electrical/Electronic

- Conductor Materials
- Contact Materials
- Electrical Insulation and Dielectrics
- Magnetic Materials
- Semiconductor Materials

Materials, Mechanical/Structural

- Adhesives
- Composite Materials
- Metals
- Nonmetallic Materials
- Protective Coatings
- Thermal and Acoustical Insulation

Motors

- Fractional-Horsepower
- Instrument
- Integral-Horsepower
- Special

Product Design Case History

Production and Assembly Techniques

- Automatic Assembly
- Embedded Circuits and Components
- Hermetic Sealing
- Miscellaneous
- Printed Wiring
- Soldering and Solderless Techniques
- Unitized Construction

Specifications and Standards

Systems

- Amplifier Circuits
- Analysis
- Communication
- Control Case Histories
- Control
- Digital
- Drives
- Mechanical
- Modular Subsystems
- Recording

Test and Measurement

- Components
- Environmental
- General
- Materials
- Production
- Systems